

1. **Project Title:** Direct Seeding into Heavy Irrigated Stubble as an Alternative to Burning
2. **Submitted to:** Agricultural Burning Practices and Research Task Force
3. **Funding Request:** \$21,983

Project Contact: Dr. William F. Schillinger, Scientist and Extension Specialist, Department of Crop and Soil Sciences, Washington State University, P.O. Box B, Lind, WA 99341.
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4. **Project Coordinator:** W.F. Schillinger

5. **Major participants:**

Dr. William Schillinger, WSU research agronomist, Lind, WA.
Mr. Harry Schafer, WSU research technician, Lind, WA. Tel: 509-677-3671.
Mr. Bruce Sauer, WSU farm manager, Lind, WA. 677-3671.
Mr. Steve Schofstoll, WSU technical assistant, Lind, WA. 677-3671.
Mr. Brian Fode, WSU utility worker, Lind, WA. 677-3671.

6. **Cooperators:**

Dr. Doug Young, WSU agricultural economist, Pullman, WA. Tel: 335-1400.
Dr. Tim Paulitz, USDA-ARS plant pathologist, Pullman, WA. 335-7007.
Dr. Ann Kennedy, USDA-ARS soil microbiologist, Pullman, WA. 335-1554
Mr. Jeff Schibel, grower, Odessa, WA. 982-0136.
Mr. Neil Fink, grower, Odessa, WA. 982-2806.
Mr. Clark Kagele, grower, Odessa, WA. 982-2825.
Mr. Gary Schell, grower Moses Lake, WA. 764-0305.
Mr. John Aeschliman, grower, Colfax, WA. 397-3118.
Mr. Perry Dozier, grower, Waitsburg, WA. 337-2137.
Mr. Keith Schafer, grower, Odessa, WA. 982-2454.

B. PROPOSAL SUMMARY

Title: Direct Seeding into Heavy Irrigated Stubble as an Alternative to Burning.

A group of deep-well irrigated cereal growers approached Bill Schillinger in 1998 concerning the future of their farming operations. The growers saw the "writing on the wall" for reduction or elimination of cereal stubble burning and felt they needed research on how to farm profitably without field burning. During several sessions with growers and researchers in 1998 and 1999, a long-term experiment was developed (see Project Narrative and Materials and Methods sections). The experiment involves both crop rotation and stubble management factors. Implementation of the project began in 1999 with startup funds provided by the EPA. Subsequent (one-year) funding was provided by the Washington DOE.

This complex and labor-intensive replicated experiment has 40 individual plots and covers 10 acres at the Washington State University Dryland Research Station at Lind. All plots receive 16 inches of irrigation water per year and fertilizer rate among all crops is held constant. The

three major objectives are: i) to test a 3-year crop rotation of winter wheat - spring barley - winter canola direct-seeded into standing stubble, after mechanical removal of stubble, and after burning the stubble. The check treatment is annual winter wheat planted after stubble burning + moldboard plowing (see Appendix 1); ii) to evaluate and develop effective techniques for planting crops into heavy surface stubble using direct seeding methods, and; iii) to document cumulative effects of a diverse direct-seed crop rotations under three stubble management practices on grain yield, soil physical and biological properties, water use efficiency, diseases, weed ecology, and farm economics.

Growers, scientists, and support staff meet each year to view field plots and discuss/evaluate progress. Growers play a key role as advisors and are involved in all major decisions. This project provides irrigated growers in east-central Washington new information on the feasibility of a diverse 3-year crop rotation with different stubble management practices. Expected outcomes are development of effective new strategies for direct seeding into heavy surface stubble. This will include documentation of changes across cropping systems and stubble management practices on: i) soil quality parameters such as organic carbon, microbial biomass, aggregate stability, etc.; ii) an economic analysis of cropping practices; iii) the extent of soil-borne disease pressure; iv) soil water dynamics and water use efficiency as affected by residue management and cropping systems; v) a complete assessment of weed species in each of the systems; and vi) an understanding of the long-term agronomic feasibility of intensive irrigated cropping without burning or tillage.

This project is shown and discussed each year at the Lind Field Day (average attendance is 190) as well as at other times to groups of students, agency personnel, growers, and scientists. Results are also presented at regional meetings and at national scientific conferences. Written results have been, and will continue to be, extended in popular grower publications, university extension bulletins, and in refereed scientific journals. This study has already received regional and national media attention and is viewed by many as a keystone research project for direct seeding in the Pacific Northwest.

C. PROJECT NARRATIVE

1. Background

Many deep-well irrigators in east-central Washington practice a continuous winter wheat rotation (i.e., grow winter wheat on the same field every year). Irrigated wheat grain yields range from 90-to 140-bushels per acre with residue production of 10,000 pounds or more per acre. After grain harvest in August, the traditional practice is to burn the stubble, irrigate, and invert the surface soil with moldboard plow tillage in preparation for sowing in September. Generally, growers feel they need to burn their fields because high residue levels hamper seeding operations. Alternatives to field burning are needed to reduce smoke emissions and maintain air quality.

Another reason why irrigated growers burn and moldboard plow winter wheat stubble is to control downy brome, a winter annual grass weed. Previous research has shown that long-term control of downy brome is very difficult in continuous irrigated winter wheat using no-till. Therefore, new crop rotation and stubble management strategies are needed to make no-till (without burning) work. Smoke emissions from burned cereal stubble in irrigated (and high rainfall area) fields is a major air quality concern. New farming methods are needed that

eliminate the need to burn. Research is needed to develop non-burn farming methods for high-residue situations that are agronomically and economically feasible.

2. Related and Current Work in the Area

Researchers at the University of Idaho are investigating alternatives to burning Kentucky bluegrass fields. Tim Paulitz, and Dave Huggins are studying direct-seed cropping systems in the high-precipitation region on the WSU Cunningham Farm near Pullman.

3. Objectives

The objective of this long-term (6-year) project is to determine the feasibility of direct seeding into high levels of residue as a substitute for burning in irrigated cropping systems. Specific objectives are to:

1. Test a 3-year crop rotation of winter wheat - spring barley - winter canola. Crops will be planted with a Cross-slot direct-seed drill into (i) standing stubble, (ii) after mechanical removal of stubble, and (iii) after burning the stubble. An additional treatment of annual winter wheat planted after stubble burning + moldboard plowing (sown with a double-disc drill) will be included as a check.
2. Evaluate and develop effective techniques for planting crops into heavy surface stubble using direct seeding methods.
3. Document cumulative effects of a diverse direct-seed crop rotation under three stubble management practices on soil physical and biological properties, water use efficiency, diseases, weed ecology, and farm economics. Compare these effects to those under the check treatment (i.e., continuous winter wheat after stubble burning + moldboard plowing).

4. Approach: Materials & Methods

Field Layout: This irrigated cropping systems study requires numerous field operations be conducted in a timely manner throughout the year (see Appendix 1). The study is located at the WSU Lind Research Station where we have the facilities, equipment, and personnel to closely supervise this complex and labor-intensive experiment.

The study was initiated in August 1999 on 10 acres of prime cropland at the Washington State University Dryland Research Station at Lind. To obtain baseline residue levels to begin the experiment, the entire 10 acres was planted uniformly to irrigated Madsen winter wheat in September 1999. Grain yield (harvest August 2000) was 110 bu/a and straw production exceeded 10,000 lb/a.

Since August 2000 (the 2001 crop year), a 3-year crop rotation of winter wheat - spring barley - winter canola is grown under three stubble management methods. Crops are planted: *i*) directly into standing stubble, *ii*) after mechanical removal of stubble (i.e. after swathing and bailing), and *iii*) after burning of stubble. A check treatment of continuous annual winter wheat planted after stubble burning + moldboard plowing is also included. The experimental design is a split-split plot with four replications. Each portion of the 3-year direct-seed crop rotation in each stubble management method is sown each year. Thus there are 40 plots (3 crops x 3 stubble

management practices + the check continuous winter wheat x 4 replications).

All direct-seeded plots are planted with a low-disturbance "Cross-slot" drill that delivers seed and liquid fertilizer in one pass through the field. The burn + moldboard plow continuous winter wheat check plots receive granular fertilizer before moldboard plowing and are planted with a double disc drill with 6-inch row spacing. A total of 15 inches of irrigation water (6" fall, 9" spring) is applied to all crops. Fertility rate of 170 lb N, 40 lb P, and 40 lb S held constant for all crops in all rotations.

Planting spring barley into heavy winter wheat stubble has not been a problem because over-winter decomposition makes the straw fairly friable. Spring barley is easy to establish and weeds can be readily controlled in this crop.

In August of 2001 and 2002, we direct seeded winter canola into barley stubble just after barley harvest into dry soil and then add 6 inches of irrigation water. The subsequent barley volunteer plants were controlled using Assure II grass herbicide. We achieved excellent stands of winter canola using this method, but the "green bridge" carryover from the dying barley volunteer caused pythium and rhizoctonia disease in the canola seedlings (Schillinger, et al., 2002). Thus, our strategy from fall 2003 onwards is to add three inches of irrigation water just after barley harvest, wait 10 days and then kill the barley volunteer with paraquat (a fast acting contact herbicide), plant canola, and add an additional 3 inches of irrigation water to insure good canola emergence.

There have been no differences in wheat, barley, or canola grain yields among direct-seed residue management treatments during the first three years of the experiment, but the continuous annual winter wheat in the burn/plow treatment was significantly lower (most likely due to take-all disease) than the winter wheat yields in rotation in 2003 (data not shown).

In the 3-year rotation, irrigation water is applied in late August into standing stubble, after burning of stubble, and after mechanical removal of stubble (see Appendix 1: calendar of operations). The burn + moldboard plow annual winter wheat check plots are prepared by first burning all above-ground residue, irrigating, fertilizing with granular fertilizer, and completely inverting the top 5 inches of soil by moldboard plow, packing the soil surface, and planting with a double-disc drill.

Measurements: Comparisons among stubble management systems within the 3-year rotation as well as with the traditional annual winter wheat using burn/plow are made. Soil water is measured to a depth of six feet in all 40 plots just after harvest and again in mid-April (before spring irrigation water is applied) using neutron attenuation and gravimetric methods. Weed species composition, number, and dry biomass in each plot are measured just before harvest within a 6 ft x 6 ft sampling square.

Diseases in all crops are measured several times during the growing season by Tim Paulitz, USDA-ARS plant pathologist. As soil biological changes are occurring relatively rapidly (Stubbs et al., 2004), complete 0-to 4-inch surface soil cores from all 40 plots are analyzed each

year by Ann Kennedy, USDA-ARS soil microbiologist. The soil properties analyzed include bulk density, pH, electrical conductivity, organic matter, aggregate stability, and organic C and N. Soil microbial analysis includes soil biomass, respiration, and enzyme activities using phospholipid fatty acid and fatty acid methyl ester (FAME) analyses. An economic analysis of the 3-year rotation vs. annual winter wheat and among residue management treatments will be conducted at the conclusion of the experiment by Doug Young, WSU agricultural economist.

Grain yield is measured by first cutting 2-ft-wide alleys to separate the no-till treatments (i.e. standing stubble, stubble mechanically removed, and stubble burned), and harvesting each 165 ft-long treatment using a plot combine and then weighing each sack of grain on a digital scale. These methods allow us to obtain very precise grain yield measurements. A commercial-size combine, equipped with straw chopper and chaff spreader, is used to harvest remaining grain and uniformly spread residue and chaff in each treatment.

5. Anticipated Schedule for Achieving Objectives

We are now in the 5th year of this 6-year project. The project is on schedule to achieve all objectives by the year 2006. Results will be presented in extension bulletins and refereed scientific journals beginning in 2007.

6. Evaluation

Scientists, support staff, and a seven-member grower advisory committee meet at Lind each year to view field plots and discuss/evaluate progress. This project was designed in collaboration with growers and they play a key role as advisors. The grower advisors are involved in all major decisions.

This project provides irrigated growers in east-central Washington new information on the feasibility of a diverse 3-year crop rotation with different stubble management practices. Expected outcomes are development of effective new strategies for direct seeding into heavy surface stubble. This will include documentation of changes across cropping systems and stubble management practices on: i) soil quality parameters such as organic carbon, microbial biomass, aggregate stability, etc.; ii) an economic analysis of cropping practices; iii) the extent of soil-borne disease pressure; iv) soil water dynamics and water use efficiency as affected by residue management and cropping systems; v) a complete assessment of weed species in each of the systems; and vi) an understanding of the long-term agronomic feasibility of intensive irrigated cropping without burning or tillage.

This project is shown and discussed each year in early June at the Lind Field Day (average attendance is 190) as well as to several other groups. Results are also presented at regional meetings, scientific conferences, and referred journals (see reference section). Written results will be further extended in popular grower publications, university extension bulletins, and in refereed scientific journals upon completing of the field research.

D. BUDGET AND JUSTIFICATION

(see budget sheet attached)

Line A: Salaries and Wages

| | |
|--|------------------|
| Graduate Student, MS, Year 1, support for 2.25 months | |
| \$11,655 x .25 | 2,914.00 |
| Wages for time slip Steve Schofstoll at \$18.75 per hour | |
| 250 hours x 18.75 | 4,688.00 |
| Benefits | |
| Graduate student, support for 2.25 months | 1,921.00 |
| Time slip \$4,688 x .44 | <u>2,063.00</u> |
| Total Salaries, Wages and Benefits | 11,586.00 |

Line E: Material and Supplies

| | |
|---|-----------------|
| Material and supplies are fertilizer, seed, herbicide, diesel, gasoline, and parts for field equipment | |
| Total Line E | 2,030.00 |

Line J: All other direct costs

| | |
|--|-----------------|
| 3 months of office rent for Principal Investigator - \$300 x 3 | 900.00 |
| 3 months of office rent for Technical Research Assistant and Research Technician - \$400 x 3 | 1,200.00 |
| 3 months of local phone bill for Principal Investigator, Technical Research Assistant and Research Technician \$200 x 3 months | 600.00 |
| 3 months of cellular phone bills \$80 x 3 | 240.00 |
| 1 month for Cindy Warriner for technical assistance, field work, preparation of graphs and tables and presentations | 1,200.00 |
| Total Line J | 4,140.00 |

TOC = \$17,756

| | |
|------------------|----------|
| Indirect costs | |
| (\$16,258 x .26) | 4,227.00 |

Grand Total 21,983.00

E. REFERENCES

- Kennedy, A.C., T.L. Stubbs, and W.F. Schillinger. 2004. Soil and crop management effects on soil microbiology. p. 295-326. *In* F. Magdoff and R.R. Weil (eds.) *Soil Organic Matter in Sustainable Agriculture*. CRC Press, Boca Raton, FL.
- Schafer, H.L., W.F. Schillinger, B.E. Sauer, A.C. Kennedy, and T.C. Paulitz. 2003. Direct seeding into heavy residue or irrigated crops as an alternative to burning. Soil and Water Conservation Society annual meeting, 28-31 July, Spokane, WA. *SWCS Annual Conf. Abstracts*, p. 53.
- Schillinger, W.F. 2004. Innovative cropping systems research at the Washington State University Dryland Research Station. [CD-ROM]. American Society of America annual meeting, 1-4 Nov., Seattle, WA. *ASA, CSSA, and SSSA Abstracts*.
- Schillinger, W.F., T.C. Paulitz, and A.C. Kennedy. 2002. Direct seeding into heavy irrigated cereal stubble instead of burning. [CD-ROM]. Soil Science Society of America annual meeting 11-14 Nov., Indianapolis, IN. *ASA, CSSA, and SSSA Abstracts*.
- Schillinger, B., H. Schafer, B. Sauer, T. Paulitz, A. Kennedy, D. Young, S. Schofstoll, and B. Fode. 2004. Irrigated cropping systems research at Lind. p. 23. *In* 2004 Field Day Abstracts: Highlights of Research Progress. Dept. of Crop and Soil Sciences Tech. Report 04-2, WSU, Pullman, WA.
- Stubbs, T.L., A.C. Kennedy, and W.F. Schillinger. 2004. Soil ecosystem changes during the transition to no-till cropping. p. 105-135. *In* D. Clements and A. Strestha (eds.) *New Dimensions in Agroecology*. Hawthorn Press, New York, NY.

F. CURRENT AND PENDING SUPPORT

See attached Current and Pending Support form.

G. VITAE

See attached vitae.

Appendix 1: Generalized schedule of annual field operations for the irrigated cropping systems experiment at Lind, WA.

- July: -Harvest canola.
- Aug: -Harvest wheat and barley.
 -Mechanically remove stubble by swathing and bailing in 3-year rotation.
 -Burn stubble in designated areas in the 3-year rotation as well as in the continuous annual winter wheat plots.
 -Apply paraquat contact herbicide to kill volunteer barley.
- Sept. -Direct seed and fertilize winter canola @ 6 lb/a with 120 lb N, 40 lb P, and 40 lb S per acre into previous barley crop (i.e. standing stubble, mechanical stubble removal, and stubble burned).
 -Apply 6 inches irrigation water all plots.
 -Broadcast dry fertilizer (120 N, 30 P, 30 S) in continuous annual winter wheat plots.
 -Moldboard plow and pack continuous winter wheat plots.
 -Apply post-harvest herbicide (glyphosate @ 22 oz./a) to wheat stubble and canola stubble.
 -Direct seed winter wheat @100 lb/a and fertilize (120 lb N, 30 lb P, and 30 lb S per acre as liquid Solution 32) into winter canola stubble.
 -Seed continuous annual winter wheat plots @100 lb/a with double-disc drill.
- Mar. -Apply post-harvest herbicide (glyphosate @ 22 oz./a) to wheat stubble.
 -Apply Assure II @ 8 oz./a to winter canola.
- Apr. -Direct seed spring barley @ 100 lb/a and fertilize 170 lb N, 30 lb P, 30 lb S per acre into winter wheat stubble.
 -Top dress winter wheat and winter canola with granular N @ 50 lb N per acre.
 -Apply 1.5 pints per acre bronate in-crop broadleaf herbicide to winter wheat.
 -Irrigate 3 inches all plots.
- May -Apply 1.5 pints bronate in-crop broadleaf herbicide to spring barley.
 -Irrigate 6 inches all plots.
- Jul/Aug: -Harvest winter canola, winter wheat, and spring barley.
 -Cycle begins again.

UNITED STATES DEPARTMENT OF AGRICULTURE
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE

OMB Approved 0524-0039

Expires 03/31/2004

BUDGET

| | | | | | | | |
|--|--|---|----------|---|---|---|--|
| Organization and Address Crop and Soil Sciences - WSU PO Box 646420, Pullman, WA 99164 | | | | USDA Award No. | | | |
| Principal Investigator(s)/Project Director(s) William F. Schillinger | | | | Duration Proposed Months: 12 <i>Funds Requested by Proposer</i> | Duration Proposed Months: 12 <i>Funds Approved by CSREES (If Different)</i> | Non-Federal Proposed Cost-Sharing/ Matching Funds (If required) | Non-Federal Cost-Sharing/Matching Funds Approved by CSREES (If Different) |
| A. Salaries and Wages | | CSRS FUNDED WORK MONTHS | | | | | |
| 1. No. of Senior Personnel | | Calendar | Academic | Summer | | | |
| a. (Co)-PI(s)/PD(s) | | | | | | | |
| b. Senior Associates | | | | | | | |
| 2. No. of Other Personnel (Non-Faculty) | | | | | | | |
| a. Research Associates | | | | | | | |
| b. Other Professionals | | | | | | | |
| c. 1 Graduate Students | | | | | 2,914 | | |
| d. Prebaccalaureate Students | | | | | | | |
| e. Secretarial-Clerical | | | | | | | |
| f. 1 Technical, Shop and Other | | | | | 4,688 | | |
| Total Salaries and Wages | | | | | 7,602 | | |
| B. Fringe Benefits (If charged as Direct Costs) | | | | 3,984 | | | |
| C. Total Salaries, Wages, and Fringe Benefits (A plus B) | | | | 11,586 | | | |
| D. Nonexpendable Equipment (Attach supporting data. List items and dollar amounts for each item.) | | | | | | | |
| E. Materials and Supplies | | | | 2,030 | | | |
| F. Travel | | | | | | | |
| G. Publication Costs/Page Charges | | | | | | | |
| H. Computer (ADPE) Costs | | | | | | | |
| I. Student Assistance/Support (Scholarships/fellowships, stipends/tuition, cost of education, etc. Attach list of items and dollar amounts for each item.) | | | | | | | |
| J. All Other Direct Costs (In budget narrative, list items and dollar amounts, and provide supporting data for each item.) | | | | 4,140 | | | |
| K. Total Direct Costs (C through I) | | | | 17,756 | | | |
| L. F&A/Indirect Costs (If applicable, specify rate(s) and base(s) for on/off campus activity. Where both are involved, identify itemized costs included in on/off campus bases.) 26% of MTDC | | | | 4,227 | | | |
| M. Total Direct and F&A/Indirect Costs (K plus L) | | | | 21,983 | | | |
| N. Other | | | | | | | |
| O. Total Amount of This Request | | | | 21,983 | | | |
| P. Carryover -- (If Applicable) | | | | Federal Funds: \$ _____ | Non-Federal Funds: \$ _____ | Total: \$ _____ | |
| Q. Cost-Sharing/Matching (Breakdown of total amounts shown on line O) | | | | | | | |
| Cash (both Applicant and Third Party) | | | | | | | |
| Non-Cash Contributions (both Applicant and Third Party) | | | | | | | |
| Name & Title (Type or print) | | Signature (required for revised budget only) | | | Date | | |
| Project Director William F. Schillinger | | | | | | | |
| Authorized Organizational Representative Dan Nordquist, Director | | | | | | | |
| Signature (for optional use) | | | | | | | |

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0524-0039. The time required to complete this information collection is estimated to average 1.00 hours per response including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Form CSREES 2004 (12/2000)

UNITED STATE DEPARTMENT OF
COOPERATIVE STATE RESEARCH, EDUCATION, AND EXTENSION SERVICE
CURRENT AND PENDING

William F. Schillinger

Expires 3-31-2005

Instructions:

1. Record information for active and pending projects. (Concurrent submission of a proposal to other organizations will not prejudice its review by CSREES).
2. All current efforts to which principal investigator(s) and other senior personnel have committed a portion of their time must be listed, whether or not salary for the person involved is included in the budgets of the various projects.
3. Provide analogous information for all proposed research which is being considered by, or which will be submitted in the near future to, other possible sponsors including other USDA programs.

| <i>Name (List #1 PI first)</i> | <i>Supporting Agency & Agency Number</i> | <i>Total \$ Amount</i> | <i>Effective & Expiration Dates</i> | <i>% of Time Committed</i> | <i>Title of Project</i> |
|------------------------------------|--|----------------------------|---|--------------------------------|--|
| <i>Active:</i> | | | | | |
| W. F. Schillinger | Vogel Wheat Fund | \$20,000 | 07-05 - 06-06 | 10% | Wheat agronomy research for low-rainfall dryland |
| W. F. Schillinger | USDA - STEEP | \$18,135 | 07-04 - 06-07 | 3% | Late seeded wheat on chemical fallow |
| W. F. Schillinger | USDA-CSREES #2004-06230 | \$50,000 | 07/04 - 06/06 | 20% | Control of wind erosion and PM-10 particulate emissions from agricultural lands in the PNW Columbia Plateau |
| <i>Pending:</i> | | | | | |
| W. F. Schillinger | USDA-CSREES | 49,000 | 07-05 - 06-07 | 20% | Control of wind erosion and PM-10 particulate emissions from agricultural lands in the Pacific Northwest Columbia Plateau |
| W. F. Schillinger | Vogel Wheat Fund | \$20,000 | 07-06 - 06-07 | 10% | Wheat agronomy research for low-rainfall dryland |
| W.F. Schillinger | DOE | \$21,983 | 11-05 to 05-07 | 10% | Direct Seeding into Heavy Irrigated Stubble as an Alternative to Burning |

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a valid OMB control number. The valid OMB control number for this information collection is 0524-0039. The time required to complete this information collection is estimated to average 1.00 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed and completing and reviewing the collection of

VITA - William F. Schillinger

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POSITION RESPONSIBILITIES: Provide leadership for cropping systems research (85%) and extension (15%) in low-precipitation (6-to 12-inch annual) dryland areas of eastern Washington. Research is focused on determining best management practices for reducing wind erosion, improving winter wheat stand establishment, decreasing water runoff from frozen soils, increasing cropping intensity, and developing technologies for no-till annual cropping which includes alternative crops. Serve as director of the WSU Dryland Research Station at Lind and as principal investigator for the Columbia Plateau PM₁₀ Project.

EDUCATION: Ph.D., Crop Science, Oregon State University, 1992; M.S., Agronomy, University of California at Davis, 1983; B.A., Communications, Eastern Washington University, 1974.

PUBLICATIONS:

Book Chapters

- Schillinger, W.F., R.I. Papendick, S.O. Guy, P.E. Rasmussen, and C. van Kessel. 2005 (in press). Dryland cropping in the western United States. In G.A. Peterson, P.W. Unger, and W.A. Payne (eds.) Dryland Agriculture. Agronomy Monograph . ASA, CSSA, and SSSA, Madison, WI.
- Kennedy, A.C., T.L. Stubbs, and W.F. Schillinger. 2004. Soil and crop management effects on soil microbiology. p. 295-326. In F. Magdoff and R.R. Weil (eds.) Soil Organic Matter in Sustainable Agriculture. CRC Press, Boca Raton, FL.
- Stubbs, T.L., A.C. Kennedy, and W.F. Schillinger. 2004. Soil ecosystem changes during the transition to no-till cropping. p. 105-135. In D. Clements and A. Shrestha (eds.) New Dimensions in Agroecology. Hawthorn Press, New York, NY.

Refereed Journal Articles

- Williams, J.D., S.B. Wuest, W.F. Schillinger, and H.T. Gollany. 2005. Rotary subsoiling newly planted winter wheat fields to improve infiltration in frozen soil. *Soil & Tillage Research* (in press).
- Schillinger, W.F., and D.L. Young. 2004. Cropping systems research in the world's driest rainfed wheat region. *Agronomy Journal* 96:1182-1187.
- Juergens, L.A., D.L. Young, W.F. Schillinger, and H.R. Hinman. 2004. Economics of alternative no-till spring crop rotations in Washington's wheat-fallow region. *Agronomy Journal* 96:154-158.
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- Schillinger, W.F., R.J. Cook, and R.I. Papendick. 1999. Increased cropping intensity for dryland with no-till barley. *Agronomy Journal* 91:744-752.
- Schillinger, W. F., R.I. Papendick, R.J. Veseth, and F.L. Young. 1999. Russian thistle skeletons provide residue in wheat-fallow cropping systems. *Journal of Soil and Water Conservation* 54:506-509.
- Schillinger, W.F., E. Donaldson, R.E. Allan, and S.S. Jones. 1998. Winter wheat seedling emergence from deep sowing depths. *Agronomy Journal* 90:582-586.
- Schillinger, W.F., and R.I. Papendick. 1997. Tillage mulch depth effects during fallow on wheat production and wind erosion control factors. *Soil Science Society of America Journal* 61:871-876.
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PREVIOUS EXPERIENCE:

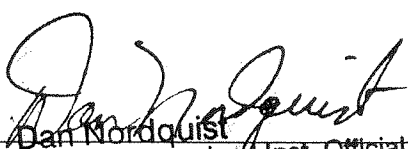
- 1999-2005 Associate Scientist and Extension Specialist E-3, Department of Crop and Soil Sciences, Washington State University, Dryland Research Station Lind, WA.
- 1993-1999: Assistant Scientist and Extension Specialist E-2, Department of Crop and Soil Sciences (1995-1999), and Agronomy Extension Agent (1993-1995), Washington State University, Dryland Research Station, Lind, WA.
- 1989-1992: Graduate Research Assistant, Department of Crop and Soil Science, Oregon State University, Corvallis, OR.
- 1986-1989: Cropping Systems Research Agronomist, Winrock International / USAID, Kathmandu, Nepal.
- 1983-1986: Agriculture Project Manager (Foreign Service Officer), U.S. Agency for International Development, Cameroon, West Africa.
- 1975-1981: American Peace Corps, Kathmandu, Nepal. Agricultural Program Director (1979-1981); Seed Specialist (PCV) (1975-1978).
- Other: Grew up on family's dryland wheat farm in Adams County, Washington.

Appendix A

CERTIFICATIONS AND ASSURANCES

I/we make the following certifications and assurances as a required element of the bid or proposal to which it is attached. I/we understand that the truthfulness of the facts affirmed here and the continuing compliance with these requirements are conditions precedent to the award or continuation of the related contract(s):

1. The prices and/or cost data have been determined independently, without consultation, communication or agreement with others for the purpose of restricting competition. However, I/we may freely join with other persons or organizations for the purpose of presenting a single proposal or bid.
2. The attached proposal or bid is a firm offer for a period of 60 days following receipt, and it may be accepted by the Department of Ecology without further negotiation (except where obviously required by lack of certainty in key terms) at any time within the 60-day period.
3. In preparing this proposal or bid, I/we have not been assisted by any current or former employee of the State of Washington whose duties relate (or did relate) to this proposal, bid or prospective contract, and who was assisting in other than his or her official, public capacity. Neither does such a person nor any member of his or her immediate family have any financial interest in the outcome of this proposal or bid. (Any exceptions to these assurances are described in full detail on a separate page and attached to this document.)
4. I/we understand that the Department of Ecology will not reimburse me/us for any costs incurred in the preparation of this proposal or bid. All proposals or bids become the property of the Department, and I/we claim no proprietary right to the ideas, writings, items, or samples.
5. I/we understand that any contracts awarded as a result of this RFP will contain terms and conditions substantially similar to those attached as Appendix B. I/we certify that I/we will comply with these or substantially similar Terms and Conditions if selected as a contractor.



 Dan Nordquist
 Signature Director, Authorized Inst. Official
 Office of Grant and
 Research Development

5/16/05, 2005

 Title